ICT Requirements for Smart Grids development at Elektro Gorenjska

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Abstract

Technological advancements, new business models, digitalization, current political trends and climate policies have all caused a significant global transformation in the energy sector, especially in the area of electricity distribution. Elektro Gorenjska, one of five Slovenian distribution network operators is no exception. The increased penetration of renewable energy sources, integration of more demanding loads such as heat pumps, electric vehicles and electric cooling, new energy markets and market players, emergence of microgrids and other circumstances are all calling for continuous progress of electricity grids, also at Elektro Gorenjska. The challenge today is mostly on the low voltage networks which has historically unfortunately not been the highest priority in network development. Furthermore it is increasingly evident that traditional network reinforcements will not be sufficient to support modern energy policies and emerging markets. Only a combined approach with the inclusion of novel approaches and technologies to distribution management will help power distribution companies pave the path to stable, secure, resilient, reliable and flexible networks.

Smart Grids which hope to adequately address modern challenges represent the third big investment cycle in the continuous construction and development of electricity power systems. The first cycle was the construction of the primary power systems from early electrification to late 1990s. The second was related to automatization of power systems. Both resulted in a quality and cost-effective electricity supply for end consumers. Both also had clearly defined concepts of construction and development. This will have to apply also for the development of Smart Grids and all of its underlying elements. This article focuses on one of these elements for the successful implementation of Smart Grids at Elektro Gorenjska.

ICT technologies represent the cornerstone in the development of Smart Grids where a top down overview compatible with the Smart Grids reference architecture model is required at all times, even when the system is built bottom-up. This is also the approach undertaken at Elektro Gorenjska.

At the component layer we are installing multiple different measuring devices at different voltage levels. Our smart meter roll-out rate is at 60% with the goal of reaching 100% by the year 2021. At the low voltage side of distribution transformers at secondary substations we are installing power quality measuring devices with the purpose of monitoring both operational parameters of the network as well as monitoring the quality of distributed energy. On the medium voltage network we have substantially increased the scope, quality and resolution of operational measurements gathered through protection relays installed on medium voltage feeders in primary substations. Furthermore we collect operational measurements from primary energy transformers and their associated secondary and protection equipment as well as energy measurements at the interface with Slovenia's TSO. The are also various operational measurement being collected from the power grid itself especially from relays associated with remotely controlled switchgear equipment. All of the listed component help to increase the observability of our network and consequently enable an improved decision making process based on relevant information.

There are multiple technologies currently installed at the communication layer. The predominant technology for data collection from smart meters is still Power Line Communication. Nevertheless, this field of communication technologies has received major attention in the last few years both in the terms of stricter requirements as well as in terms of advancements. Progress has been made to collect data via push mechanisms instead of traditional pull mechanisms where demonstrations have proven that push mechanism provide greater performances with additional room for improvement. Straying away from traditional PLCs there has been significant development in the direct reading of smart meters through devices installed directly on the I1 output of the smart meter. This data collection mechanism appears to be the most prospective for the future, however there are still multiple obstacles that need to be overcome. Apart from technical limitations that currently still hinder wider implementation of this concept there are still additional considerations in the terms of data privacy and GDPR that have to be considered in this respect. Furthermore a specific communication technology for home area networks has yet to emerge as the clear winner for data collection and processing in the future. Currently Elektro Gorenjska is conducting pilot projects in this area. Traditionally networks beyond the meter have been outside of the domain of distribution system operaters, but with the requirements of emerging markets and growing technical challenges at end points of distribution networks, near real-time operational data from smart meters is becoming more and more vital for system operations and development of new energy markets.

One specific related to the area of ICT that separates Elektro Gorenjska from other Slovenian DSOs is the ownership of a private communication network operated on a privately owned frequency band. Elektro Gorenjska uses a 3,5GHz frequency band to implement WiMAX technology based on IEEE 802.16 standard to cover roughly 70% of the area Elektro Gorenjska supplies. This approach has proven to be cheaper, more reliable and more effective compared to utilization of public telecommunication networks. We still utilize public telecommunication networks for the remaining 30% where WiMAX infrastructure requirements are too high. The WiMAX communication network is used for the transfer of operational measurements and power quality parameters from power quality measuring devices on low voltage networks as well as the transfer of metering data from concentrators related to the advanced metering infrastructure. Currently the WiMAX network is being upgraded on a major scale in a pilot project. The end goal is to upgrade our private WiMAX communication network to a Private LTE communications network based on a 700MHz frequency band. Early results are promising, however the full implementation is not expected before 2020 because of the scope and broadness of the geographical area where modifications are required.

Other standard communication technologies that Elektro Gorenjska utilizes for various purposes include Synchronous Digital Hierarchy or more specifically the next generation SDH called TDM telecommunication technology which is currently undergoing a modernization and digitization effort. The end result will be the development of a new generation telecommunications network based on IP protocols. A detailed analysis has been undertaken to identify required bandwidths, transfer speed, transfer priorities for all different services. These services include Substation and Distribution Automation, Remote Control and Reserve Control Centre, Protection Control, Voltage Regulation, Power Quality Monitoring, Metering data at the TSO/DSO interface, Time Synchronization, Alarm Systems and Video Surveillance, Access Control, Access to the business network for field crews, etc…

Also operational but on a smaller scale are other ICT technologies such as fiber optics, standard communication technologies for voice communication, digital radio and others for effectively managing work orders, field crews, remotely controlled switchgear equipment and in some cases also data collection from concentrators related to smart meters and power quality measuring devices.

At the information layer Elektro Gorenjska has successfully implemented the Common Information Model in accordance with the IEC61970 and IEC61968 family of standards. The CIM enables Elektro Gorenjska to pursue a modern, systematic and standards-based integration of technical and business information systems which coincides with a service oriented architecture concept. We have already successfully integrated several applications within the distribution control centre such as SCADA, DMS, OMS and the system for operational measurements. Further plans include the integration of a GIS system which will serve as the main data source in terms of topological network modelling for other systems as well as the integration of several other systems such as the meter data management system, network planning system, asset management system and other business related back-end systems.

All of these underlying layers effectively enable Elektro Gorenjska to develop business procedures on the function layer of the Smart Grid Reference Architecture as well as pursue and realize business objectives, economic goals and regulatory policies on the business layer. In this regard Elektro Gorenjska is very active in the following areas: Increased Network Observability, Increased Network Control, Advanced Protection Schemes, Advanced Distribution Management, Demand and Generation Side Management. One simple use case example of a business procedure on the function layer would be the development of consumption control with the combination of data from operational measurements from power quality measuring devices and metering data from smart meters. Other more complex examples will include increased cooperation and information exchanges through standard platforms with Slovenia’s TSO in the scope of new requirements and development of energy markets such as the predicted flexibility market.